Applying the Theory of Planned Behavior to Individual Computer Energy Saving Behavioral Intention and Use at Work

Full paper

Carol E. Pollard
Appalachian State University
pollardce@appstate.edu

Abstract

The Theory of Planned Behavior (TPB) has been used in many different contexts, but rarely in the area of sustainability. This study utilized the framework of the TPB to explore factors associated with individual computer energy saving behavior and use across a medium-sized US university. A simple energy-saving device was attached to the workstation of 147 faculty, staff and administrators for a period of 8-weeks and behavioral intention and actual hours used were measured. Structural equation modeling analysis confirmed the role of perceived behavioral control but did not support the roles of attitude or subjective norm in influencing behavioral intention. A particularly interesting result was low predictive power of the TPB on actual use and negative relationship between behavioral control and use which is contrary to those of previous studies that typically use self-report measures of use rather than objective measures of actual use. Theoretical and practical implications are discussed.

Keywords

Energy saving behavior, Green IT, Theory of Planned Behavior, structural equation modeling.

Introduction

Reducing energy use through conservation and efficiency has been identified as one of the more cost-effective options for meeting targets for significant reductions in greenhouse gas emissions worldwide (Alcott & Mullainathan 2010; Carrico and Riemer 2011). A recent Global Industry Analysts' report demonstrates a growing interest in green initiatives in that Green IT services are expected to surpass US$5 billion by 2015 based on data collected from key players in the global market including Accenture PLC, BT Global Services, Deloitte, Global Green Consulting Group, Inc., Hewlett-Packard Company, International Business Machines Corporation, SustainableIT, Tata Consultancy Services, Computer Sciences Corporation, Dell, Inc., Intel Corporation and Oracle, among others (Legg 2010).

It is widely acknowledged that green IT has the potential to create new competitive opportunities, reduce carbon emissions, and improve overall business efficiency. There is evidence that business sustainability initiatives can build better brand image, mitigate environmental liabilities that come from a firm's product and services, and influence the customers and investors mindset. These initiatives can range from green strategy, green supply chain management, and implementation of energy-saving technologies (Molla, 2008). Encouraged by the success of the energy star rating program and the general concept of energy conservation, state and federal governments in the U.S. and across the globe are developing regulations and standards to encourage the adoption of energy conservation technologies in both the public and private sectors (Pollard, 2013).

Melville (2010) suggests that technology is "an important but inadequately understood weapon in the arsenal of organizations in their quest for environmental sustainability by enabling new practices and processes in support of belief formation, action formation, and outcome assessment". Green IT has been defined in a number of different ways, however, there appears to be agreement on a common theme of IT reducing waste, and improving systems. For the purpose of this paper, Green IT refers to the

> "systematic application of environmental sustainability criteria to the design, production, sourcing, use and disposal of the IT technical infrastructure as well as within the human and managerial components of the IT infrastructure in order to reduce IT, business process and supply chain related emissions and waste and improve energy efficiency." (Molla, 2008).

According to Molla (2008), Green IT offers improvements from three perspectives: operational, service and sourcing.

- **Operational:** improving energy efficiency in powering and cooling corporate IT assets and reducing IT induced greenhouse gas emissions.
- **Service:** the role of IT in supporting a business's overall sustainability initiatives.
- **Sourcing:** the practice of environmentally preferable IT purchasing.

The current research is focused primarily on the operational perspective in that the installed energy saving device reduces IT-induced greenhouse gas emissions and peripherally addresses the service perspective in that it supports the business' overall sustainability initiatives and the sourcing perspective, in that its purchase is environmentally preferable.

Consider that there are over 1.6 Billion PCs worldwide in 2011, of which 310.6 Million (19.4%) are in the United States (eTForecasts 2012) and most are regularly left on overnight or all weekend. Each computer workstation uses about 120W of energy per hour with a 50/50 split of energy consumed between the computer and the display screen and it has been estimated that if computer workstations are completely shut off over nights and weekends, their collective energy use can be reduce by at least 50% and a savings of $55 can be realized for every 1,000 kilowatt-hours (kWh) saved (BC Hydro 2014).

This suggests that even in a small firm there is a potential for significant energy savings through computer power management. Unfortunately, there is empirical evidence that while people claim that energy savings is important to them, they often exhibit limited willingness to act and actual savings do not meet expectations. Consequently, while all computers have power management and automated shutdown features that support a person's intention to conserve significant amounts of energy and reduce carbon emissions, most users don't take advantage of these obscure features. Bamberg (2013) refers to this phenomenon as the 'intention-behavior gap'.

Although sustainability has been assessed for various domestic behaviors, far fewer studies have reported on what motivates IT-related sustainability behavior at work despite the fact that globally the total CO_2 emissions from industry is three times that of residential consumers. Carrico and Reimer (2011) caution against extrapolating the findings of sustainability research based on domestic behavior to the workplace since the motivations to engage in sustainable behavior at work and at home can be very different. For example, energy consumption, is for the most part, invisible to the user. This is particularly true in a work setting where employees typically have no direct financial interest in conserving energy (Carrico and Riemer 2011). As a result, few people understand the difference they can make by changing their day-to-day behavior to achieve better energy efficiency outcomes at work.

In the 2012 academic year, System Center Configuration Manager (SCCM) and Windows 7 was implemented to enable Technology Support Services (TSS) at a medium-sized, Southeastern university to perform power management, including computer bios settings and power equipment 'on' or 'off' at set intervals. TSS was able to change maintenance cycles to one day a week instead of requiring that computers were on all of the time to receive updates. This drastically improved overall powered-on time. With SCCM, TSS managed the computer lock and sleep settings to 30 minutes of inactivity on all faculty, staff and administrator PCs across campus. TSS did not perform a complete shut off on faculty, staff and administrator PCs since they considered the windows 7 sleep mode to be 'pretty energy efficient'.

Clearly, this institution-level strategy relative to IT energy conservation indicated to employees that energy savings was a high priority at the university. However, there was strong resistance to the top-down strategy as constituents expressed their doubts about whether any energy savings were actually being achieved. As a result, the technology-driven, institutional-level energy-conservation initiative was discontinued. The study reported here was designed, in consultation with the Director of TSS, as a follow-up to this failed initiative to explore the motivators of individual-level energy saving behavior and voluntary use of university employees. In the following sections, TPB literature is reviewed, the energy saving device is described, survey development is discussed, data collection and analysis procedures and results are described and finally a discussion of conclusions and practical implications is provided.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) has received empirical support in predicting behavioral intentions across various sustainability contexts including energy conservation (Carrico and Reimer 2011), water conservation (Lam 2006; Clark and Finley 2007) online environmental community member's intention to participate in environmental activities (Park and Yang 2012) and adoption of smart metering technology (Kranz and Picot 2012). The TPB has three core predictor variables: attitudes, subjective norm and perceived behavioral control that influence behavioral intention and use (Figure 1). A central factor within the theory is an individual's *intention* to engage in a given behavior. As a general rule, the stronger the intention to engage in a behavior, the more likely a person will be to actually perform the behavior. However, it is the concept of perceived behavioral control that distinguishes the TPB (Ajzen 1985, 1991) from the earlier Theory of Reasoned Action (Fishbein and Ajzen 1975). Ajzen (1985, 1991) defines 'perceived behavioral control', as the measure of a person's perception of the ease of difficulty of performing a given behavior.

In keeping with its goal of *explaining*, rather than just *predicting*, behavior, the theory includes two other components. These are *attitude toward the behavior* and *subjective norm*. Attitude toward the behavior measures the degree to which a person has a favorable or unfavorable evaluation of the behavior being measured, while subjective norms measure the likelihood that important reference individuals or groups approve or disapprove of performing the behavior.

The theory holds that the stronger the attitude toward the behavior, subjective norm and perceived behavioral control, the more likely the person will engage in the behavior. However, the extent to which any of these components individually or severally predict the performance of behavior can be expected to vary across contexts and behaviors. Indeed, a number of sustainability studies have reported a weak relationship between environmental attitudes and environmental behavior (Kaiser, Wolfing and Fuhrer 1999; Park and Yang 2012) and perceived behavioral control and intention (Kranz and Picot 2012; Park and Yang 2012; Greaves, Zibarras and Stride 2013).

Thus the TPB is, in principle, open to the inclusion of additional predictors if it can be shown they capture a significant proportion of the variance in intention or behavior after the theory's current variables have been taken into account. Since the focus of the current study is on sustainability at work, the additional variable "attitude to sustainability at work" was added to the research model to more accurately reflect the research context and a relationship between general attitude and behavioral intention through sustainability at work was hypothesized to address Azjen's (1991) note that "broad attitudes and personality traits have an impact on specific behaviors only indirectly by influencing some of the factors that are more closely linked to the behavior in question" (p. 181).

In their meta-analysis of TPB studies, Armitage and Conner (2001) reported that on the whole, perceived behavioral control and attitudes are better predictors of behavior than subjective norm, which tends to vary considerably across behaviors and situations. In the context of sustainability activities mixed results have been reported. Some have found that attitude toward an advocated behavior is a valuable predictor of pro-environmental intentions and actions (Lubell 2002, Postmes and Brunsting 2002; Greaves, et al. 2013) while others have found evidence to the contrary (Park and Yang 2012) and Kranz and Picot (2012) found no support for the influence of perceived behavioral control on intention in their study of consumer intentions to adopt smart metering technology.

The majority of TPB studies limit their data collection to measuring the relationships between the core variables (as added contextual variables) and self-reported behavioral intention Kranz and Picot 2012; Park and Yang 2012; Greaves, et al. 2013). To test the TPB in the context of sustainability behavior at work in a cross section of faculty, administrators and general staff at a medium-sized university, based on the mixed results of previous studies, eight hypotheses examined the relationships between the latent variables and <u>use</u> as diagrammed in the research model presented as Figure 1.

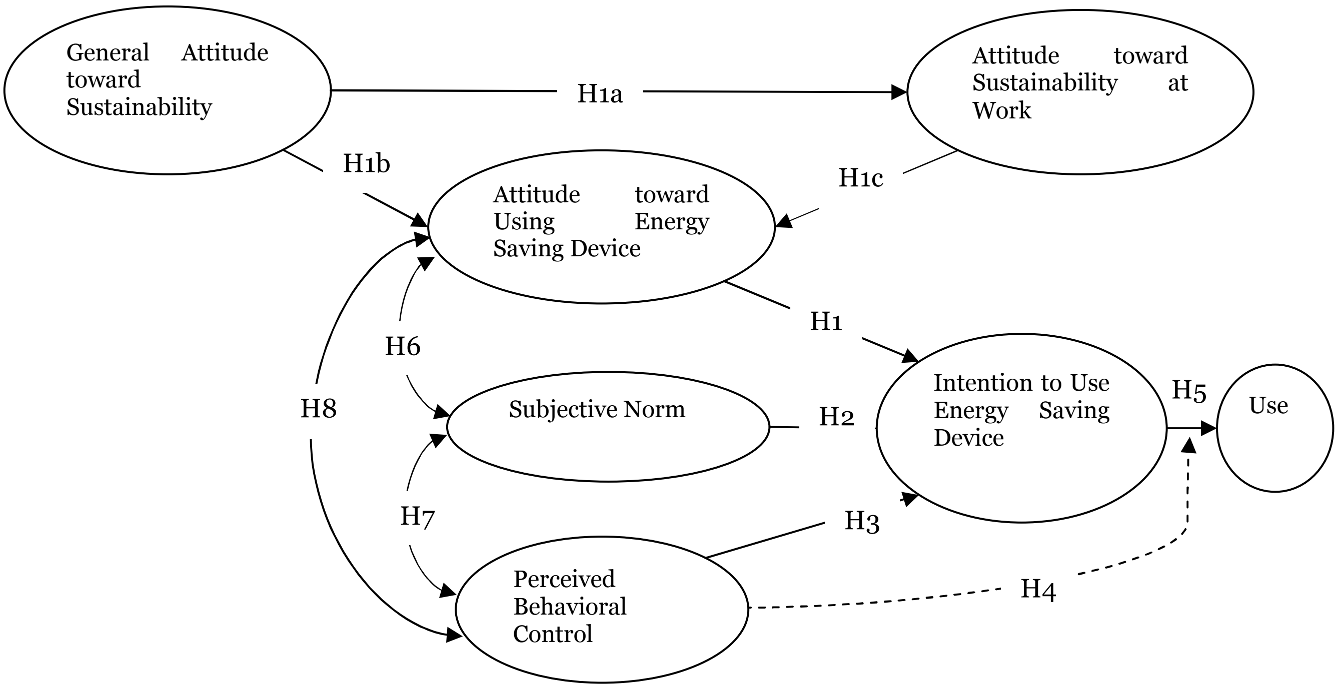

Figure 1. Research Model

Energy Saving Device The computer energy saving device installed was the Eco-button™, a small round plastic push-button that plugs into a USB port of the computer. The Eco-button™ is activated by a single 'push' each time the computer user takes a break, makes a phone call, attends a meeting or otherwise temporarily discontinues use of their PC (Ecobutton 2012). Every PC is equipped with several power states or "S" modes, to assist with energy savings. The higher the sleep state number, the more energy is saved. However, there is an inverse relationship between energy saved and time to return to normal functionality - the higher the sleep state number, the *longer the start up or time* to return to normal functionality. In contrast, with a computer push of the Eco-button™ the computer is powered down to ensure that the computer and monitor only draw the same power as when they are shut down. When the user wants to get back to work, he/she touches any key on the computer and it *instantly* returns to where they left off without the need to wait for the computer to reboot.

In addition, the Eco-button™ provides the user with regular feedback on energy saved (Figure 2). Each time the user returns to the computer after 'powering it down' using the Eco-button™, a full-screen pop-up displayed the actual savings in dollars and Kgs recorded that day and 'to date'. This feature was considered particularly useful since it made the energy savings visible to the user.

Figure 2. Eco-button Feedback Screen

Research Method

A mixed method approach was taken in this study. Two methods of *quantitative* data collection and two methods of *qualitative* data collection were used to inform this study: Quantitative data were collected through (1) Hours used, CO2 Kgs and $$ savings measured by the Eco-button software, (2) quantitative responses from the online survey. Qualitative data were collected through a content analysis of the open-ended comments included on the online survey.

Survey Development

The individual was the unit of analysis. The online survey was developed to measure several multi-item constructs: (1) general attitude toward sustainability, (2) attitude toward sustainability at work, (3) attitude toward using the energy-saving device, (4) perceived behavioral control, (5) subjective norm and (6) perceived behavioral intention *before* installation of the energy saving device. Each of the scale items used was derived from previously validated measures with each item carefully reworded to reflect the IT sustainability research context. All items were rated on a seven-point Likert scale with the anchors 1= "very strongly disagree' and 7 = 'very strongly agree'. Negatively worded items were reverse coded. In addition, age, gender, position and level of computer experience were collected. A complete list of all latent variables, including number of items and source are shown in Table 1.

Construct	Symbol	# of Items	Source
General Attitude Toward Sustainability	GATS	3	Johnsson and Reiner, 2007
Attitude toward Sustainability at Work	ATSW	4	Varon, 2008
Attitude toward Using the Computer Energy Saving Device	ATUE	3	Ajzen, 1991
Subjective Norm	SN	3	Ajzen, 1991
Perceived Behavioral Control	PBC	4	Taylor and Todd, 1995
Behavioral Intention	BI	3	Ajzen, 1991

Table 1. Latent Variables

Data Collection

Data on energy-reduction behavior, general attitudes to sustainability, attitude toward sustainability at work attitude toward the use of the computer energy savings device, subjective norm, perceived behavioral control and behavioral intention were initially collected in a pilot study of 44 administrators, faculty and general staff members in the College of Business. The energy saving device was installed on the workstation of each volunteer, the online survey was completed and actual usage data was collected. This enabled the researcher to trial and refine the survey along with installation and data collection methods in preparation for the larger study.

A bulk email was sent to all administrators, faculty and general staff members inviting them to voluntarily enroll in the study. A total of 232 volunteers responded to the call for participation. Over a period of several weeks, appointments were made with a random sample of 150 of the volunteers, to install the energy saving device on participants' machines. At the time of installation, a consent form, participation instructions and an Eco-button flyer were given to each participant. At the time of installation, participants were also asked to complete an online survey hosted through Survey Monkey. An energy saving device was installed on 147 workstations. Three devices were not installed for various technical and timing reasons, including incompatible operating System (e.g., LINUX, MAC) and incompatibility with critical work duties (e.g., took system offline, interfered with VPN access). Eight weeks from the date of each installation, the Eco-button was retrieved and use data (hours used, Kwh, CO2 and Dollar savings) were collected and recorded from 138 of the 147 workstations. Data from nine workstations could not be collected due to replacement of workstation or upgrading of operating system after installation of the energy saving device. To preserve anonymity, each Eco-button was numbered and all data were collected and recorded based on Eco-button number, not by participant identifiers.

Data Analysis

The current study used SPSS Version 22 and Smart-PLS 3 to analyze the data. A measurement model was first estimated using Principal Components Analysis (PCA), then structural equation modeling (SEM) was used to test the causal relationships within the model. Unlike other multivariate techniques such as multiple regression, discriminant analysis, MANOVA and factor analysis, SEM combines aspects of multiple regressions and factor analysis to simultaneously assess a series of dependent relationships (Hair, Anderson, Tathan and Black 1998). Hair, et al. (1998) advocate SEM as a particularly useful tool for modeling tests that include multiple endogenous and exogenous variables and mediators/moderators.

Structural equation modeling partial least squares (SEM-PLS) was used to validate the model and measure the relationships between the six latent variables (general attitude toward sustainability, attitude toward sustainability at work, attitude toward using the energy saving device, subjective norm, perceived behavioral control and behavioral intention). In addition, the relationship between behavioral intention and use was also assessed.

Results

Survey data were collected from 145 of the 147 participants for a 98.63% return rate. These response rates are acceptable according to Neuman (2000).

Descriptive Statistics

A review of the demographics of the participants shown in Table 2 reveals a predominantly female population, the majority of whom held staff roles within the university and ranged in age from 18 to over 65 years of age. A majority of participants' considered themselves to be more knowledgeable about computers than a typical user and 11% of the participants felt they were computer experts.

Characteristic	Value	Frequency	%
Gender			
	Male	48	33.1%
	Female	97	66.9%
Age			
	18-24	3	2.1%
	25-34	28	19.3%
	35-44	33	22.8%
	45-54	46	31.7%
	55-64	32	22.1%
	65 and above	3	2.1%
Position			
	Administrator	24	16.6%
	Faculty	44	30.3%
	Staff	77	53.1%
Computer Experience			
	Novice	52	35.9 %
	Intermediate	77	53.1%
	Expert	16	11.0%

Table 2. Participant Profile – N=145

Test of Proposed Research Model

Before establishing the reliability and validity of the survey constructs, SPSS was used to conduct a Principal Component's Analysis (PCA) to determine inclusion of individual survey items. A Varimax Rotation with Kaiser Normalization revealed the factor structure and measures of composite reliability, convergent validity and discriminant validity of the variables. The measurement model performed well in that standardized factor loadings ranged from .66 to .95 on all items, thus exceeding the recommended minimum of .40 suggested by Ford, MacCallum and Tait (1986). In addition, to assess the adequacy of the correlation matrices for factor analysis, the Keyser-Meyer-Olkin Measure of Sampling Adequacy was determined. For the KMO statistic, Kaiser (1974) recommends a bare minimum of .5 and Hutcheson and Sofroniou (1999) classifies values between .5 and .7 as 'mediocre', values between .7 and .8 'good', values between .8 and .9 'great' and values above .9 'superb'. Using this classification, KMO is this study are 'great' (.82) thus indicating that the data would yield distinct factors and Bartlett's Test of Sphericity was highly significant (*p*.000). Thus, all latent variables demonstrate good internal *consistency and reliability* (Table 3).

Validity was evaluated through measures of convergent and discriminant validity. The two most reliable measures of *Convergent validity* are composite reliability and communality coefficients (Fornell and Larcker 1981). Table 3 demonstrates that composite reliabilities of all constructs ranged from .76 to .95, exceeding the recommended minimum of .70 (Nunally and Bernstein 1994) and each construct exhibits strong communality values greater than the recommended minimum of .50 (Thompson 2004). *Discriminant validity* is assessed by measuring squared average variance extracted (AVE) to explore whether variables are more highly correlated *within* each other than *with other* variables. Table 3 shows the AVE ranged from .52 to .86, exceeding the recommended minimum of .50 (Fornell and Larcker, 1981).

Correlations among latent variables								
Variable	**Symbol**	**ATSW**	**ATUE**	**BI**	**GATS**	**PBC**	**SN**	**AVE**
Attitude toward Sustainability at Work	**ATSW**	**.839**	.0762	.168	.506	.162	.028	.70
Attitude toward Using the Eco-button	**ATUE**	.276	**.870**	.0835	.032	.154	.181	.76
Intention to Use the Eco-Button	**BI**	.410	.289	**.926**	.125	.472	.066	.86
General Attitude toward Sustainability	**GATS**	.711	.180	.354	**.872**	.106	.001	.76
Perceived Behavioral Control	**PBC**	.402	.393	.687	.325	**.882**	.116	.78
Subjective Norm	**SN**	.167	.425	.257	.027	.341	**.721**	.52
Use	**AU**							
Mean*	11H, 39M	6.26	4.46	6.26	6.02	5.23	3.98	
Standard Deviation	14H, 21M	.78	.99	.89	.79	.69	.79	
Composite Reliability		.91	.90	.95	.91	.93	.76	
Communality Coefficient		.70	.75	.88	.77	.80	.65	

Bolded values on the diagonal are the square root of the AVE.

Values BELOW the diagonal are Pearson correlations (two-tailed).

Values ABOVE the diagonal are squared correlations.

All latent variables were measured on a scale of 1-7 (1=low, 7=high). 'Use' is measured in hours and minutes.

Table 3. Measures of Convergent/Discriminant Validity, Means, SD

All attitudinal/behavioral measures fell on the positive side of the midpoint of the 7-point scale, indicating a generally positive assessment of the various components of the voluntary energy saving initiative. However, the strength of their agreement varied across the model variables. While participants exhibited strongly positive attitudes to sustainability ($\bar{x}$ 6.02, SD .79) and attitude toward sustainability at work ($\bar{x}$ 6.26, SD .78), their attitude toward using the energy saving device ($\bar{x}$ 4.46, SD.99) was somewhat weaker. This suggests that while participants were socially responsible both in general and at work, some had a degree of uncertainty about the energy saving device and how it worked, since they had been involved in a mandated top-down computer energy conservation initiative that in some cases, adversely affected their ability to work when they wanted to. This uncertainty could also account for the mid-range score reported for perceived behavioral control ($\bar{x}$ 5.23, SD .69). It should be remembered that the online survey was completed in the first few days that the energy saving device was installed and their confidence level with the device may have been low for some of the novice computer users, despite the fact that all participants had been assured that support resources were readily available to them in the event they had difficulty using it. Similarly, the low score on subjective norm ($\bar{x}$ 3.98, SD .79) may reflect that participants were undecided about the opinions of those who could influence their use of the device. Finally, use ($\bar{x}$ 12 hr. 38 min., SD 14 hr. 20 min.) was lower than would be expected given the scores reported on the core variables and supports the notion of an 'intention-behavior' gap in the context of computer energy saving (Bamberg 2013).

To capture the reflective nature of the six latent variables quantitative data were entered into Smart-PLS to calculate path models and Bootstrapping was used to measure the significance of the model's path parameters. A total of 500 bootstrap samples was selected using an equal number of observations in each bootstrap sample, as recommended by Hair, Starstedt, Ringle and Mena (2012). The path coefficients and t-values are shown in Figure 3. The analysis shows that while a significant proportion (47.8%) of the variance in Intention to Use the Energy Saving Device was predicted by the core TPB variables, only a very small proportion (6%) of the variance in use was explained by the variables included in the measurement model (Figure 3).

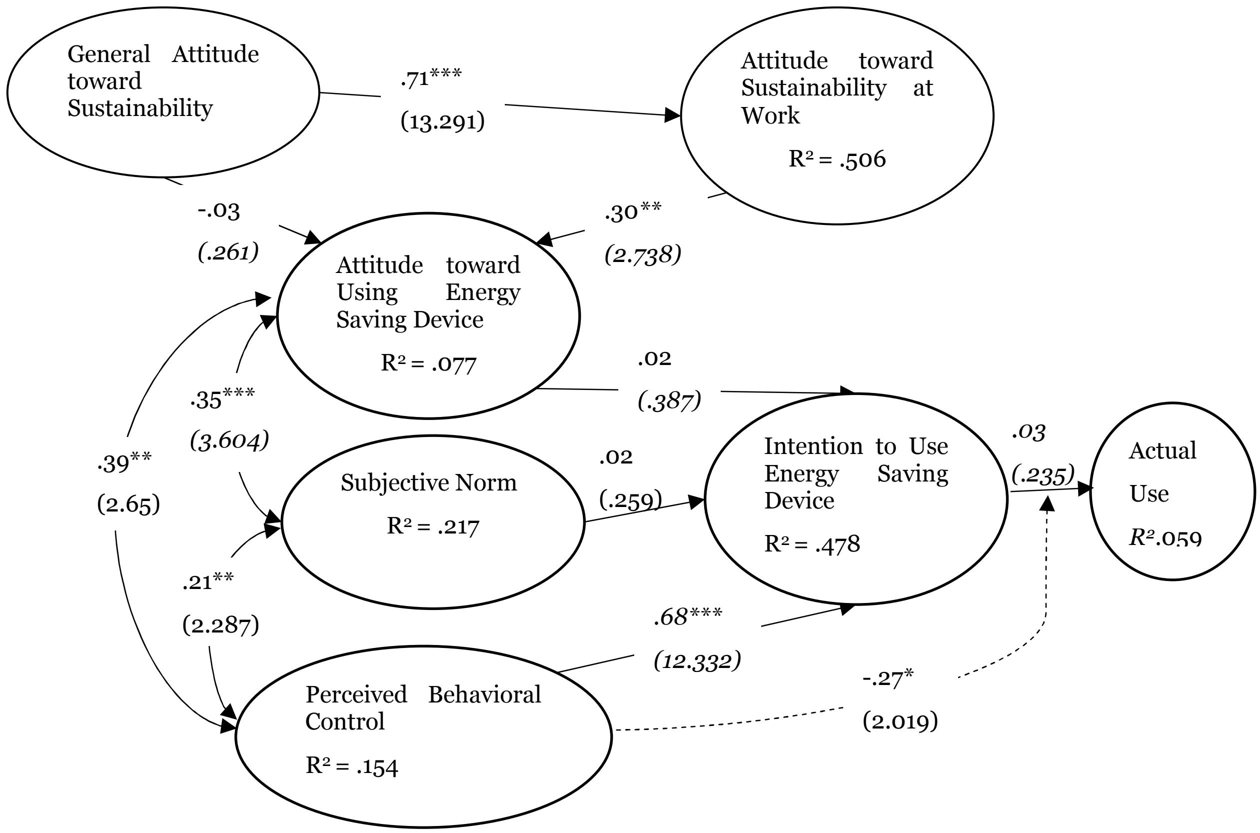

Figure 3. Measurement Model with Path Coefficients and t-values (parentheses) Statistical significance is indicated at .05 level*, at .01 level and at .001 level*****

Hypothesis Testing

Hypotheses 1 through 3 address the importance of the core TPB variables in explaining and predicting the behavioral intention of the participants to use the energy saving device. As shown in Figure 3, attitudes and subjective norm were not significantly related to intention but perceived behavioral control showed a characteristically highly significant relationship to intention to use. In assessing hypotheses 1a, 1b and 1c, general attitude toward sustainability, did not exhibit a significant direct relationship with attitude toward using the energy saving device, but it did show a strongly significant relationship to attitude toward sustainability at work, accounting for 51% of its variance and thus indirectly influenced attitude toward using the energy saving device through attitude toward sustainability at work. Attitude toward sustainability at work was strongly related to attitude toward using energy savings device supporting the need to measure specific rather than general attitudes relative to the context under investigation. Thus, hypotheses 1a and 1c are supported. Hypothesis 1b is not supported.

Hypotheses 4 and 5 measured the relationship between perceived behavioral control and use (H4) and intention and use (H5). H4 was supported at the .05 level and demonstrated there was a moderately significant negative relationship between perceived behavioral control and use. H5 was not supported. Open-ended comments provided in the follow-up survey provided some interesting insights into this discrepancy between intent and use. Content analysis of the open-ended comments in the survey revealed six main themes: (1) ease of use; (2) enjoyment, (3) feedback, (4) habit, (5) technical issues and (6) value. The themes of 'ease of use' (18) and 'enjoyment' (18) contained the most comments, followed closely by 'feedback' (12), 'habit' (11) and 'value' (10). The theme of 'technical issues' (8) contained the fewest comments.

To assess the relationships between attitude, subjective norm and perceived behavioral control, H6 through H8 were tested. Medium to strong support was found for each of these three hypotheses. Attitude toward using the energy saving device and subjective norm and perceived behavioral control were both supported at the .001 level of significance, while the relationship between subjective norm and perceived behavioral control was supported at the .01 level. Overall, the model accounted for 48% of the variance in behavioral intention, 8% of attitude toward using the energy saving device, 22% of subjective norm, 15% of perceived behavioral control and 6% of use. Table 4 summarizes the results of hypothesis testing.

Hypothesis	Path	*p-value*	Supported	Direction
H1	ATUE – BI	.798	No	Positive
H1a	GATS - ATSW	.000	Yes	Positive
H1b	GATS – ATUE	.778	No	Negative
H1c	ATSW – ATUE	.007	Yes	Positive
H2	SN – BI	.799	No	Positive
H3	PBC – BI	.000	Yes	Positive
H4	BI – Use	.820	Yes	Positive
H5	PBC – Use	.049	Yes	Negative
H6	ATUE – SN	.000	Yes	Positive
H7	SN – PBC	.007	Yes	Positive
H8	ATUE - PBC	.000	Yes	Positive

Table 4. Summary of Hypothesis Testing

Use

All but five (4%) of the participants reported using the energy saving device for some period of time throughout the 8-week study. However, those that used it differed on continuity of use. For example, seventy-three (58%) reported 'continuous' use and 47 (38%) reported 'sporadic' use of the energy-conservation device. When asked how frequently they used the energy saving device, 70 (53%) participants said they used the energy saving device to power down their computer one or more times a day, an additional 35 (28%) reported using it at one or more times per week and 9 (7%) reported using it one or more times month and 11 (9%) reported using it less than one a month.

Analysis of actual usage data shows that participants varied greatly in the number of hours they used the intervention. Usage ranged from a minimum of 0 hours to a maximum of 100 hours, 22 minutes. The average number of hours that the energy saving device was used was 12 hrs., 38 mins. (SD 14hrs. 21 mins.) This translates to approximately 90 minutes of use per week per person.

Discussion and Implications

While the results added support for the usefulness of the TPB as a socio-psychological model in the context of sustainability and confirmed the widely recognized importance of perceived behavioral control in influencing behavioral intention, it also provided support that from a theoretical perspective, the predictive power of the TPB is context sensitive. In this case, the context specific variable, 'attitude toward sustainability at work' had a highly positive significant relationship with general attitude toward sustainability and attitude toward using the saving device whereas general attitude showed a non-significant negative relationship with attitude toward using the energy saving device. A somewhat surprising finding was that attitude and subjective norm were not significantly related to intention. While these findings contrasts with those reported in much of the TPB literature, in which attitude toward the behavior was found to have the strongest relationship to behavioral intention and results for subjective norm typically show a weaker relationship to intention (Armitage and Conner 2001; Greaves, et al. 2013), it is supportive of the recent findings of Park and Yang (2012) in their sustainability studies. This finding may be explained by the strong impact of perceived behavioral control on intention which is likely to lessen the influence of attitude, suggesting that self-confidence and a perception of adequate resources may override a person's attitude when forming an intention to engage in energy saving behavior.

This conclusion is reinforced by the highly significant positive relationships indicated among attitude, subjective norm and perceived behavioral control in forming an intention to perform a behavior.

A particularly interesting result was the negative, but moderately significant relationship between perceived behavioral control and use. While this is contrary to the majority of previous findings who typically report a significant positive relationship between the two variables it finds support in similar findings reported by Cordano and Frieze (2000) in their study of behavioral pollution preferences of environmental managers. Taken together, these two non-significant relationships might be explained by the lack of consequences and/or incentives for engaging in computer energy saving at work and the short timeframe of the trial of the energy saving device. From the practical perspective, the open-ended comments concerning ease of use, habit, feedback, value and enjoyment point to a need for training workshops focused on computer energy saving to increase employee awareness of the value of engaging in sustainability behaviors, coupled with employee incentives for saving energy at work.

Future research is encouraged to further test the TPB in a wider variety of sustainability contexts to further explore the context sensitivity of the model and particularly to explore the 'intention – behavior' gap that has been largely overlooked in past research studies of the TPB in an IT sustainability context.

Acknowledgements

The author gratefully acknowledges the financial support provided by the University Research Council, Walker College of Business Dean's Club and Technology Support Services in the conduct of this research.

REFERENCES

Ajzen, I. 1985. *From intentions to actions: A theory of planned behavior*. In J. Kuhl, and J. Beckmann Eds., Springer series in social psychology pp. 11-39. Berlin: Springer.

Ajzen, I. 1991. "The Theory of Planned Behavior." *Organizational Behavior and Human Decision Processes*, (50), pp. 179-211.

Alcott, H., and Mullainathan, S. 2010. "Behavior and Energy Policy." *Science*, Vol. 327, pp. 1204-1205.

Armitage, C. and Conner, M. 2001. "Efficacy of the theory of planned behavior: a meta-analytic review." *British Journal of Social Psychology*. (40) pp. 471-499.

Bamberg, S. 2013. "Changing Environmentally Harmful Behaviors: A Stage Model of Self-Regulated Behavioral Change". *Journal of Environmental Psychology,* (34), pp. 151-159.

BC Hydro 2014. 'Turn Off Unused Computers and Equipment". Available at: https://www.bchydro.com/powersmart/business/small_medium_business/green_your_business/office_guide/Turn_equipment_off_when_not_in_use_.html. (Accessed 15 February 2015).

Carrico, A. and Reimer, M. 2011. "Motivating energy conservation in the workplace: An evaluation of the use of group level feedback and peer education." *Journal of Environmental Psychology* (31), pp. 1-13.

Clark, W. and Finley, J. 2007. "Determinants of water conservation intention in Blagoegrad, Bulgaria," *Society and Natural Resources* (20), pp. 613-627.

Cordano, M., & Frieze, I. H. 2000. "Pollution reduction preferences of U.S. environmental managers: Applying Ajzen's theory of planned behavior." *Academy of Management Journal* (43:4), pp. 627-641.

Eco-button 2012. "Ecobutton Halo, the World's 1st Behavioural Change and Savings Solution" Available from https://www.ecobutton.com (Accessed 15 February 2015)

eTForecasts 2012. "PCs In-Use Reached Over 1.6B in 2011", available from http://www.etforecasts.com/pr/pr020112.htm (Accessed 15 February 2015).

Fishbein, M. and Ajzen, I. 1975. *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading: Addison-Wesley.

Ford, J., McCallum, R. and Tait, M. 1986. "The application of Exploratory Factor Analysis in Applied Psychology: A Critical Review and Analysis." *Personnel Psychology* (39:2), pp. 291-314.

Fornell, C. and Larcker, D. 1981. "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research* (191), pp. 19-50.

Greaves, M, Zibarras, L. and Stride, C. 2013. "Using the theory of planned behavior to explore environmental behavioral intentions in the workplace." *Journal of Environmental Psychology* (34), pp. 109-120.

Hair, J., Anderson, R., Tatham, R. and Black, W. 1998. *Multivariate data analysis (8th Ed.)*, Upper Saddle River, NJ: Prentice-Hall Inc.

Hair, J., Black, W., Babin, B., and Anderson, R. 2010. *Multivariate data analysis* 7th ed.: Prentice-Hall, Inc. Upper Saddle River, NJ, USA.

Hair, J., Starstedt, M., Ringle, C. and Mena, J. 2012. "An assessment of the use of partial least squares structural equation modeling in marketing research", *Journal of the Academy of Marketing Science* (403), pp. 414-433.

Hutcheson, G. and Sofroniou, N. 1999. *The multivariate social scientist: Introductory statistics using generalized linear models*. Thousand Oaks, CA: Sage Publications.

Johnsson, F., & Reiner, D. M. 2007. Public and Stakeholder Attitudes towards Energy, Environment and CCS. In T. A. f. G. Sustainability (Ed.), AGS Pathways report 2007: E2. Göteborg: PR-Offset.

Kaiser, H. 1974. "An Index of Factorial Simplicity." *Psychometrika* (39:1), pp.31-36.

Kaiser, F., Wolfing, S. and Fuhrer, U. 1999. "Environmental Attitude and Ecological Behavior." *Journal of Environmental Psychology* (19:1), pp. 1-19.

Kranz, J. and Picot, A. 2012. "Is it Money or the Environment? An Empirical Analysis of Factors Influencing Consumers' Intention to Adopt the Smart Metering Technology." *AMCIS 2012 Proceedings*. Paper 3. http://aisel.aisnet.org/amcis2012/proceedings/GreenIS/3

Lam, S. 2006. "Predicting intention to save water: Theory of planned behavior, response efficacy, vulnerability and perceived efficient of alternative solutions". *Journal of Applied Social Psychology* (36), pp. 2803-2824.

Legg, T. 2010. "Global Green IT Services Market Projected to Reach US$5 Billion by 2015". Accessed at: http://www.25degrees.net/news-and-press-releases/item/2209-global-green-it-services-market-projected-to-reach-us-5-billion-by-2015.html. (Accessed 15 February 2015)

Lubell, M. 2002. "Environmental activism as collective action". *Environment and Behavior* (34), pp. 431-454.

Melville, N. 2010. "Information Systems Innovation for Environmental Sustainability." *MIS Quarterly* (34:1), pp. 1-21.

Molla, A. 2008. "GITAM: A Model for the Adoption of Green IT". *Proceedings of the Australasian Conference on Information Systems*. Accessible from: http://www.bsec.canterbury.ac.nz/acis2008/Papers/acis-0152-2008.pdf (Accessed 15 February 2015).

Neumann, W. 2011. *Social Research Methods: Qualitative and Quantitative Approaches*, 7th Edition. Allyn and Bacon: Boston

Nunally, J. and Bernstein I. (1994). *Psychometric Theory*, 3rd Edition. McGraw-Hill, Inc" New York.

Park, N. and Yang, A. 2012. "Online environmental community members' intention to participate in environmental activities: An application of the theory of planned behavior in the Chinese Context". *Computers in Human Behavior* (28), pp. 1298-1306.

Pollard, C. 2013. "The US Government's Evolving Role in IT Energy Management". *IT Professional*, Vol. 15, No. 1, pp 36-43.

Taylor, S., & Todd, P. (1995). "Assessing IT Usage: The role of prior experience." *MIS Quarterly*, (19), pp. 561-568.

Thompson, B. (2004). "Communality". In Michael S. Lewis-Beck, A. Fryman & Time Futing Liao (Eds.) *The SAGE Encyclopedia of Social Science Research Methods*. (pp. 148-149). Thousand Oaks, CA: Sage Publications, Inc. doi: http://dx.doi.org/10.4135/9781412950589.n139

Varon, E. 2008. "CIO's Green IT Survey: Cost Cutting, Social Responsibility Drive Environmental Moves" *CIO,* March 17 2008. Available from http://www.cio.com/article/2436955/it-organization/cio-s-green-it-survey--cost-cutting--social-responsibility-drive-environmental-moves.html Accessed 15 February 2015.